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An Empirical Study on the Factors Driving the Pricing of New Condominiums in Proximity to Bangkok Commuter Train Systems

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Abstract. Studies have verified significant effects on condominium pricing of a given building's structural characteristics and its proximity to train stations; however, in the few empirical studies that have examined both proximity to mass transit train stations and structural characteristics of the condominiums in Bangkok, little detail has been given on how the data were gathered. Despite the relatively acceptable quality of the collected data, the explanations of how the authors accessed and recorded the web-based data were unclear and inadequate. We thus want to fill this void. Hence, our main research purpose was to test if the structural factors of new condominiums around the Bangkok rail system and their proximity to train stations could significantly determine the pricing. Using data from one real estate website, regression analysis on 1,600 observed condominium units confirmed the significant effects on pricing of structural attributes and distance to the nearest train station. In addition to the extension of theoretical insights into the driving factors of the pricing, real estate developers may apply the findings to optimize their pricing practices.

Keywords: Pricing, New Condominiums, Bangkok Commuter Train Systems, Proximity

1. Introduction

Real estate developers have long recognized business opportunities presented by a commuter rail system. Researchers have verified that the pricing of these new condominiums is significantly determined by the proximity to train stations. For example, Sirikolkarn (2008) used data from realtors to confirm this effect on condominium price offers. Such effects have also been identified in Malaysia and Turkey (Dziauddin, 2019; Kaya & Atan, 2014). Three railway services that comprise the Bangkok commuter train systems -- the Bangkok Transit System (BTS), Metropolitan Rapid Transit (MRT), and Airport Rail Link (ARL) -- have offered train services for residents of metropolitan and suburban Bangkok since 1999, and proximity to the commuter rail stations of these three services is an essential component of condominium pricing strategies.

Although the effects have been verified in various contexts (Dziauddin, 2019; Sirikolkarn, 2008; Xiao, et al., 2019), a review of previous work highlights research possibilities. First, nearly all past research provided little detail on how the data were gathered, which leads to a few questions about the data quality, the findings or the conclusions. The pricing is important, and it could be conceptualized from the demand side or the supply side, but it is unclear in many studies which side the authors have taken. Only Kulkosa (2016) stated clearly that she collected the price data based on how much the condominium targets were willing to pay. Many researchers claimed that they gathered the pricing data from the supply side, but their papers have insufficient detail to ascertain the quality of the data. Generally speaking, no sellers want to disclose how they price their offers. Hence, research that relies on the use of a questionnaire to gather pricing data from the large pool of samples is often questionable. Second, a fair number of previous researchers claim that they elicited actual pricing from online announcements such as those in realtor websites. For instance, Dai (2019) collected the condominium pricing in Stockholm from Booli Search Technologies but the distance to mass transit system was not their focus. Also, Dziaudin (2019) claimed to gather the price offers of new condominiums in Malaysia and was able to confirm that it was driven by how close the housing projects to the rail stations. Despite the relatively acceptable quality of the collected data, the explanations of how the authors accessed and recorded the web-based data were unclear. Finally, only few empirical studies have examined both proximity to mass transit train stations and structural characteristics of the condominiums in Bangkok (Tochaiwat, 2021; Tochaiwat, et al., 2017). Despite their promising findings, the explanation of the data acquisition is inadequate. Hence, our main research purpose was to test if the structural factors of new condominiums around the rail system and their proximity to the train stations could significantly determine the pricing.

2. Literature review

Currently, three parties (i.e., BTS, MRT and ARL) offer commuter train services to the residents of Bangkok and surrounding vicinity. BTS was the first of these commuter rail services to begin operations, which commenced in December 1999. Later, in 2004, the MRT launched a second commuter rail system in Bangkok, which, at the time, comprised a single underground subway line that connected to the existing BTS skytrain. Finally, the ARL system was launched in 2010 to serve commuters and air passengers traveling between downtown Bangkok and Suvarnabhumi airport. Collectively, these train services have been operating for longer than 20 years, and they have attracted the development of tremendous new condominium projects (Thamrongsrisook, 2011). According to Dziauddin (2019), people are willing to pay high prices for housing that is near mass transit train stations.

The three major commuter train service providers collectively serve an average of 1.2 million riders daily (Mass Rapid Transit Master Plan in Bangkok Metropolitan Region, 2023). The systems have a combined track length of about 167.6 kilometers, with at least 100 stations, and they are still expanding. Several of the stations allow passengers to connect from one rail system to another. For instance, the BTS Asoke station provides an interchange with the MRT line's Sukhumvit station. In 2024, two new lines will be in service (Yellow Line (Bangkok), 2023). See Figure 1 for the geographical details of the

three train service providers. Readers should note that Figure 1 is accurately created to accommodate only the current research. In 2023, new tracks (e.g., the Red Line) are integrated into the Bangkok Commuter systems but their stations are out of the scope of our project.

Since their inception, Bangkok's commuter train systems have had a significant impact on the prices of real estate close to their stations. Examining the effects of the Silom and the Sukhumvit routes on pricing of the then-new condominiums alongside them, Kulkosa (2016) confirmed the significant impact of this proximity on pricing. A year later, Serearuno (2017) focused exclusively on the Sukhumvit line to research the transit-oriented development of the BTS stations. He first classified the stations into three clusters, and then tested to see if the pricing of the condominiums in the three clusters were explained by the selected factors. Common to all three clusters was the distance to the nearest station, which was found to explain a significant portion of the pricing. However, these past studies captured only part of the commuter rail systems, which is among their major limitations.

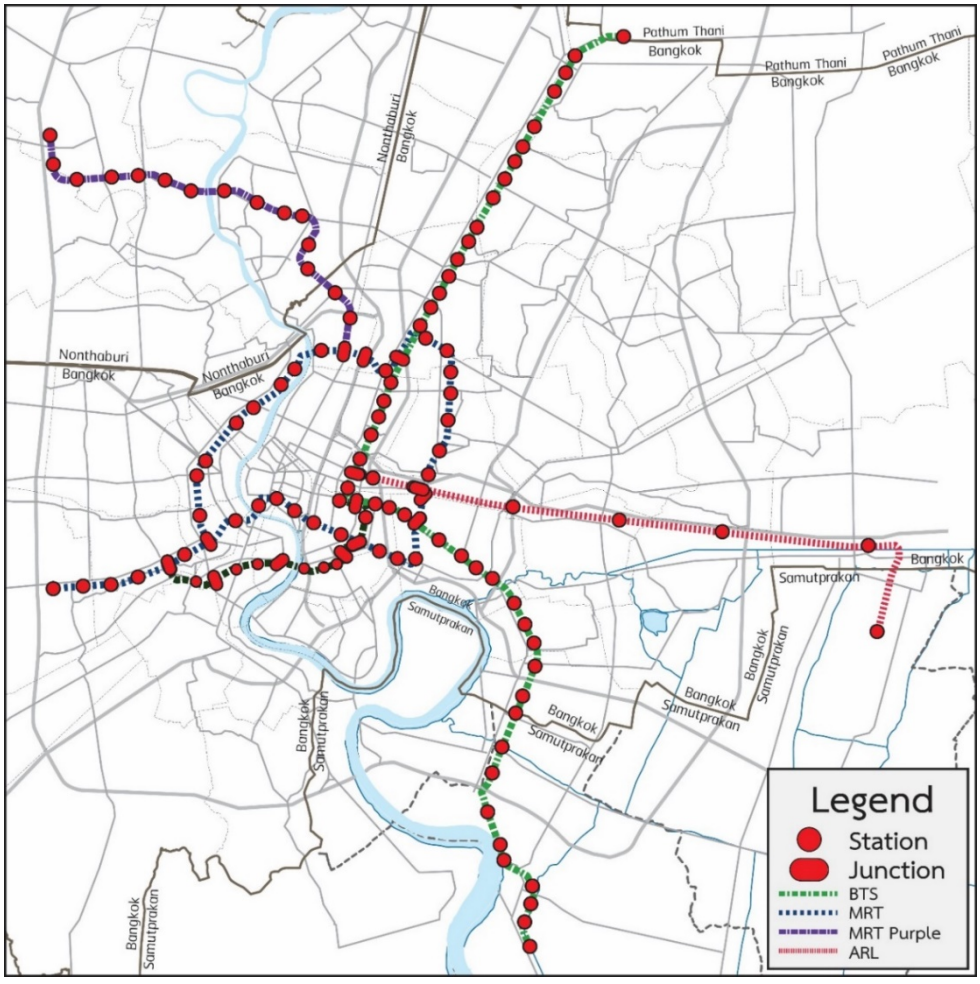

Fig.1: Geographical detail of the Bangkok Commuter Rail providers

Based on previous research that examined determinants of condominium price offers, those determinants can be grouped into two categories. First, the characteristics of the condominiums often drive how developers price their offers. In his thesis, Thamrongsrisook (2011) confirmed that the room size, the number of floors, and the building age were significant determinants of the pricing. However, his sample of 63 units was relatively small, and the method of data collection was unclear. Another study -- one which examined factors influencing the pricing of condominiums in Stockholm -- confirmed the significant effects of a large set of structural variables (Dai, 2019). For instance, it was found that if the condominium for sale was on a high floor, its price was higher than those on lower floors. Also, of course, large rooms were pricier than small ones. Dai (2019) also confirmed the negative impact of the total number of units on its pricing. In other words, condominiums in buildings with a small number of units were more expensive than those in buildings with a large number. One of the drawbacks in Dai's (2019) study was that accessibility to certain locations (e.g., the proximity to train stations) was excluded from the research. A study in Kuala Lumper, Malaysia identified the effects of building facilities on the condominium pricing (Dziauddin, 2019; Techakumphu, 2015). Such facilities included a gym area, swimming pool, or a jogging track, each of which was treated as a binary variable. One of the notable findings in Dziauddin (2019) is that the authors gathered the actual pricing of 476 condominiums for sale from one website. The only unclear issue is how Dziauddin (2019) accessed the web-based data, as there was no detail given in the paper. If it was done manually, it could have distorted the study reliability.

Among the structural characteristics, we are particularly interested in seven of them. They are (1) the total number of floors; (2) the total number of condominium units; (3) the parking spaces; (4) the gross floor area, which was included as a control variable; and whether the building has (5) a swimming pool, (6) a fitness or a gym area, or (7) a business lounge. For the final three facilities, we created a proxy variable called facility scores which combines the value of the three binary variables. As such, there is the total of five structural variables in the current study. Their definitions are in Table 1.

Table 1: Definitions of key variables

Variables	Definitions
Y: Listed price of condominiums (Baht)	The condominium price listed for sale on the website
S1: The number of floors	The total number of floors in the building where the condominium is listed
S2: The number of condominium units	The total units of condominiums in the building where it is listed
S3: Percentage of parking (%)	The number of parking spots divided by the total number of condominium units
S4: Facility scores	The total of the binary indicators of whether the condominium project has a swimming pool, a fitness area, or a business lounge
S5: Gross floor area (m2)	The total area of the condominium in square meters that the owner can utilize
L1: Walking distance to the nearest station	The walking distance from the building to the nearest station on a commuter train line (km)
L2: Driving distance to the nearest station	The driving distance from the building to the nearest station on a commuter train line (km)

Second, a condominium's location attributes play a key role in its pricing. An interest in secondhand condominium pricing led Tochaiwat, et al. (2017) to gather the data on 200 samples and verify that the distance to mass transit stations was a negative and significant determinant of their pricing. In addition, Tochaiwat, et al. (2017) included in their study certain structural characteristics. The examples included

whether the rooms were fully furnished, whether they were in high-rise buildings, or whether they came with kitchen utensils. This is one of few studies addressing both structure and location factors to explain condominium pricing. Yet, their explanation on how data was obtained was unclear, and their focus was not on new condominiums. In an investigation of condominiums in Malaysia (Dziauddin, 2019), the distances to neighborhoods were significant in determining pricing. It is slightly disappointing, however, that the distance to a mass transit train station was not. Yet, one of the important variables was whether the buildings were located within an 800-mteter radius from a mass transit station. Such an odd application of the location traits, however, was likely confusing to readers. One remark on Dziauddin's (2019) work was that Euclidean distances were used instead of the walking or the driving distances to the stations. While valid, the Euclidian figures often provide an unrealistic measurement of the practical distance as compared to other two. In economic research, Kulkosa (2016) used geographically weighted regression to validate that the location attributes suggested no spatial dependency among the collected prices. Using multiple regression, she later confirmed that proximity to a BTS station was one of the attributes that could significantly explain pricing (Kulkosa, 2016). In addition, the amount of car parking was also found to be significant. Like other previous work, details on data collection in Kulkosa (2016) were unclear, meaning that the quality of the conclusions is still debatable.

The two location factors we include in the current study are (1) the walking distance (in kilometers) from the building to the nearest train station, and (2) the driving distance measured in a similar manner. We decided not to use the Euclidean distance (i.e., the direct path) because the walking and the driving distances are more practical in terms of the determinants of the condominium pricing than the direct path. The definitions of these two distances are in Table 1. How these two distances were measured is explained in the research methodology section.

A review of previous literature addressing the factors that explain condominium price offers suggests three research gaps. First, there appears to be no empirical work which examines the effects of the influential factors chosen from the structural characteristics and from the location attributes on the pricing of new condominiums in Bangkok. Previous research (e.g., Dziauddin, 2019; Thamrongsrisook, 2011, Tochaiwat, 2020; Tochaiwat, et al., 2017) has addressed only a fraction of the entire picture. Nevertheless, it provides a firm foundation for the current study. Second, only a small amount of research has provided adequate details how the methods of data collection with respect to pricing and other factors, which raises quality issues. In our study, the pricing data is collected from the supply side; hence, it is a requirement that reliable details be available from the condominium sellers. Despite this consideration, asking vendors directly, either via interview or questionnaire, may still be unreliable since the methods by which the sellers price their offers is largely confidential. Finally, a few of the previous publications claimed their data were harvested from reliable sources, including real estate websites. While such data are of acceptable quality, many researchers provided little explanation about how the data were collected and recorded for the subsequent analyses. In other words, it is unclear from the papers how researchers accessed online data, how the proximity to the mass transit train station was measured, or how to collect the structural variables with acceptable quality. Therefore, we attempted to access and gather from one real estate website the actual pricing of new condominiums listed for sale together with all determining factors. Our main goal is to test if the pricing is significantly driven by at least one of these factors.

3. Research Methodology

3.1. Data preparation

Our aim was to empirically verify whether the five factors derived from the structural characteristics (i.e., the number of floors, the number of units, the parking proportion, the facility scores, and the gross floor area) and the two locational factors (i.e., the walking and the driving distances to the nearest

commuter train station) could significantly determine the pricing of new condominiums in Bangkok. So, the unit of analysis must be one new condo unit for sale, and the research approach is quantitative. We developed a python script that crawled one real estate portal website. Given the open-source nature of the task, our script employed general programing libraries that allowed researchers to replicate similar studies. The name of the website is withheld for research etiquette, but it is one of the top property portal websites in Thailand (Umbelina, 2019). It functions as a mediator, matching potential buyers and sellers. Tested several times to ensure its capabilities, the script went to the website's "new condominiums" section and selected all entries announcing the sale of new condominium units from November 2021 until February 2022, during which time we were able record 1,600 units, which was deemed statistically adequate, given the seven independent variables and one dependent variable used in our analysis (Kerlinger & Lee, 2000). The details of the sale announcements allowed us to record the listed price, the total number of floors, the total number of units, the parking proportion, and the gross floor area, and to calculate the facility scores. Also included in the announcements are the condominium locations (i.e., latitude and longitude scales) together with the locations of train stations. We were, therefore, able to calculate the walking and driving distances to the nearest stations. In some cases, a condo unit was situated between two train stations. In these cases, a comparison was made to determine the proper nearest distance.

In Table 2 are the number of condominium units observed on each track. Readers should note that a few stations had no condo units for sale at the time of data collection. 46.1% of the units in our dataset were close to the BTS line while 45.2% were near an MRT station. Table 3 displays the counts of the observed condominium units classified by the number of bedrooms. As expected, the one-bedroom type is the most commonly observed (42.9%). Readers should also note (1) 319 out of the observed 1,600 units did not list the number of bedrooms, and (2) the penthouse style is included based on the label supplied by the unit sellers. This style may have three bedrooms or more. Given the profile of the collected units, our samples appear to be representative of the condominiums located in close proximity to the three Bangkok commuter train system stations.

Table 2: Observed condominium units classified by proximity to the three commuter rail systems

Commuter train system	Total number of train stations on the given lines where the observed units were listed (%)	Total number of observed units listed (%)
BTS (Bangkok Transit System)	32 (45.7)	738 (46.1)
MRT (metropolitan Rapid Train)	31 (44.3)	723 (45.2)
ARL (Airport Rail Link)	7 (10.0)	139 (8.7)
Total	70 (100)	1,600 (100)

Table 3: Observed condominium units classified by the number of bedrooms (n=1,281 because 319 out of the observed 1,600 units did not list the number of bedrooms)

Number of bedrooms	Counts (%)
Studio	128 (10.0)
One bedroom	549 (42.9)
Two bedrooms	420 (32.8)
Three bedrooms	104 (8.1)
Penthouse	68 (5.3)
Four bedrooms or more	12 (1.0)
Total	1,281 (100)

3.2. Data Analysis

In addition to the descriptive statistics, we used a regression technique to test the determining effects on the pricing of the condominiums of the number of floors; the number of condominium units; the parking percentage; the facility scores; and the walking and driving distances to the nearest station. Please note that the gross floor area was included in the equation as the control variable.

4. Results

As shown in Table 4, the average price of the observed condominiums was 9.46 million baht, and the average gross floor area was 63.79 m^2. The condominium buildings had an average of 532.84 units and 29.19 floors. The average parking space percentage was approximately 57% of the total number of units. The buildings in which the observed condominiums were listed had an average walking distance of 1.43 km and an average driving distance of 2.65 km to the nearest commuter rail station.

The skewness and the kurtosis statistics in Table 4 validate that nearly all variables are not normally distributed since most of their absolute values are greater than one (Muylle, et al., 2004). Hence, they were transformed using a logarithm function, after which their distributions appeared normal and parametric techniques were able to be used for further analyses.

Table 5 displays the Pearson r correlation coefficients, most of which are significant. Further, none of the independent variables is strongly correlated with another. This supports the notion of using these variables to test whether a seller's pricing was significantly determined by the selected factors.

Table 4: Descriptive statistics (n=1,600)

Variables	Mean	Standard Deviation	Skewness	Kurtosis
Y: Listed price (Baht)	9,462,542.78	21,241,369.94	7.37	72.27
S1: The number of floors	24.19	16.02	0.67	0.32
S2: The number of condominium units	532.84	514.04	1.88	4.40
S3: Percentage of parking (%)	56.97	29.48	2.22	7.14
S4: Facility scores	2.01	0.41	-0.60	6.51
S5: Gross floor area (m^2)	63.79	77.02	5.67	48.23
L1: Walking distance to the nearest station	1.43	1.33	2.47	9.27
L2: Driving distance to the nearest station	2.65	1.87	1.35	3.03

Table 5: Correlation matrix (* Significant at the level less than 0.05)

Variables	S1	S2	S3	S4	S5	L1	L2
Y: Listed price (Baht)	0.36*	-0.14*	0.54*	0.06*	0.77*	-0.17*	-0.08*
S1: The number of floor levels	1	0.37*	0.44*	0.23	0.32*	-0.28*	-0.16
S2: The number of condo units		1	-0.23*	0.09*	-0.16*	0.00	0.10*
S3: Percentage of parking (%)			1	0.19*	0.58*	-0.23*	-0.09
S4: Facility scores				1	0.11*	-0.23*	-0.08
S5: Gross floor area (m^2)					1	-0.10*	0.01
L1: Walking distance to the nearest station						1	0.49*
L2: Driving distance to the nearest station							1

Table 6 summarizes the analytic outcomes, which yield three important findings. First, the F statistic of 781.431 with the p-value of .000 confirms the explanatory effect of at least one determining factor on the pricing. Second, the statistics in Table 6 confirm the significant effect of all but the facility scores on the pricing. Finally, the adjusted r2 of 0.792 verifies the acceptable quality of all significant factors on the listed prices. In addition, the tolerance and the VIF statistics in Table 6 suggest a bearable level of multicollinearity, and the Durbin-Watson of 0.816 implies no serious concern with respect to autocorrelation in the residuals. These details confirm the acceptable quality of the regression outcomes.

Table 6: Regression analysis outcome [a]

Variables	B	Beta	t-statistics	p-value	Tolerance	VIF
S1: The number of floors	0.01	0.200	10.307	.000	0.387	2.58
S2: The number of condo units	-0.15	-0.134	-7.73	.000	0.418	2.08
S3: Percentage of parking (%)	0.59	0.248	13.82	.000	0.450	2.22
S4: Facility scores	-0.13	-0.024	1.94	.053	0.913	1.10
S5: Gross floor area (m^2) [+]	0.88	0.540	34.89	.000	0.589	1.70
L1: Walking distance to the nearest station	-0.11	-0.096	-6.04	.000	0.575	1.74
L2: Driving distance to the nearest station	-0.48	-0.039	-2.60	.009	0.647	1.55

[a] Adjusted r2 is 0.792 with the Durbin-Watson of 0.816 and the F statistics of 781.431 (p-value = .000).
[+] This factor was included as the control variable.

Moreover, the standardized (Beta) and the unstandardized (B) regression coefficients in Table 6 offer four additional findings. First, it can be expected that the gross floor area is responsible for the greatest contribution to the pricing based on its Beta of 0.540, which is the highest value shown. Simply put, the larger the condo unit, the more expensive it is. This is the main reason it was treated as the control variable in the current study. Second, the total number of floors and the parking proportion are the two non-control factors with the largest and most positive explanatory effects on pricing. This finding implies that a condominium in a high-rise building with relatively more parking can be listed at higher prices than those in low-rise buildings with a relatively smaller amount of parking. The effect of the total number of units on the pricing is also significant, but negatively correlated with prices. Further discussion is included in the next section. Third, both walking and driving distances to the nearest train station are also significantly correlated to prices for new condominiums set by sellers. These

correlations are also negative, which means the closer (or the shorter distance) to the station, the higher the price of the condominium unit. Finally, the effect of the facility scores on the pricing was not significant. Further discussion on this finding is included in the conclusion section.

5. Discussion

Using the Python script, we were able to crawl one real estate website and to record the listed prices of new condominiums in Bangkok, together with their structural characteristics and the distances to the nearest commuter train station for each development. During the four-months of data collection, the details of 1,600 condominium units for sale were gathered for subsequent analyses.

The descriptive details reveal that the condominiums in our study were listed at the average price of 9.46 million baht. The buildings in which these units were located had an average of 24.19 floors and 532.84 units. Approximately 3 out of 4 observed units had one or two bedrooms. 46% of the observed units were close to a BTS line, and 45% were located near an MRT line. BTS was the first commuter rail system in Bangkok to offer the train services, and the MRT blue line services areas that are known for luxurious residential buildings and multi-national private offices. In addition, our findings are in line with those in Kulkosa (2016). Hence, the condominiums observed in this current study appear to represent the population under investigation.

The analytic outcomes confirm that the factors selected from the structural characteristics and the location attributes were able to capture 79.2% of the pricing of new condominiums along the commuter railway systems. This is the main response to our research objectives. Speaking of the structural factors, the total number of floors, the total number of units, and the parking proportion were significant determinants of that pricing when the gross floor area is used as the control variable. While a fair amount of previous research (Thamrongsrisook, 2011; Tochaiwat, 2020; Xiao, et al., 2019) had verified the positive effects of the number of floors and the parking spaces on the pricing, our findings revealed the significant negative effect of the total number of units in the building on the pricing, which may be one unique contribution of our research. Based on these findings, new condominium units alongside Bangkok commuter train systems would be listed expensive if they are in the high-rise buildings with ample parking area. This unique contribution could further validate that developers would be able to charge higher per-unit prices by constructing taller buildings with a smaller number of units. We contemplate that the smaller number of rooms in high-rise buildings, the cozier the condominium units.

The trivial effect of the facility scores on the pricing in the current study warrants further discussion. Such findings contradict those in previous research (Tochaiwat, 2020; Xiao, et al., 2019). There are two paths of speculation. First, we developed the score by combining the three binary indicators of the pool, the gym area, and the business lounge. This was done in order to comply with the statistical assumption of the regression analysis in which independent variables should not be dichotomous; however, it may have created a cannibalizing effect on each indicator's impact on the pricing (Kerlinger & Lee, 2000). Second, the combined scores had low variance of only 0.41, which may be the underlying reason for the insignificance.

Considering the location attributes, the two distances (i.e., walking and driving routes) to the nearest train station were both significant in determining unit pricing. At the beginning of this research project, the two distances were assumed to be so heavily correlated that the regression technique would have adopted only one of them in the equation. Yet, the correlation analysis (see Table 5) proved otherwise. A comparison between these two distances revealed that the walking distance had more impact on the pricing than the driving path because the former's absolute Beta is larger than the latter's. Previous research had confirmed the substantial effects of the proximity to mass transit stations on the real estate pricing (Thamrongsrisook, 2011; Xiao, et al., 2019). However, no publication had previously observed the individual effects of walking or driving distance on condominium pricing. As such, this could be a second unique contribution of our study, and we encourage other researchers to adopt these factors as proxy constructs for the proximity in determining the real estate pricing.

6. Conclusion

Through a web-crawling technique, we were able to gather the listed price offers of 1,600 new condominium units located in proximity to Bangkok's commuter train systems. Based on the analytic results, the units can command higher prices (1) if they are in a high-rise building in which the total number of all units is relatively small, and (2) if the building is both accessible by car and is located within comfortable walking distance of the nearest train station. However, facilities such as a swimming pool or a fitness area may not add value to the unit pricing. Rather, these facilities comprise the "must-have" amenities in residential condominiums (Techakumphu, 2015).

Our findings offer both theoretical and practical contributions. Theoretically, the study extends insight into the determinants of new condominium pricing in developments located close to commuter rail stations in Bangkok. Our unique conceptual contribution is the empirical validation of the negative significant impacts of (1) the total condominium units, and (2) the proximity as measured by walking distance and driving distance to the nearest commuter rail station on the pricing. This contribution is unique because no publication has previously incorporated both walking and driving distances between the buildings and the nearest commuter train stations and tested if they could significantly explain the pricing of new condominium units. Our work is thus an additional empirical research project to the area.

Practically, our findings offer two guidelines. The first suggestion is for real estate developers. They can offer units for sale at relatively higher prices if those units are in a tall building with (1) a small number of units and ample parking spaces, and (2) offer easy accessibility to commuter rail services. This is based on our significant findings. With respect to the two distances from a condominium building to the nearest mass transit station (i.e., walking and driving), the walking distance appears to have larger impact on the pricing than does the driving distance. Nevertheless, real estate developers must take into consideration both distances when they price their condominium unit offerings. The second guideline is for potential buyers of condominiums in proximity to Bangkok's commuter train stations. Our findings may assist them to discern if the listed price is reasonable. For instance, being aware that the prices of new condominiums close to a train station are negatively correlated to the total number of units but positively related to the total number of floor levels or parking spaces, potential buyers may want to check if the listed prices consistently align with these relationships.

All research faces limitations, and the current study had two limitations of note. First, while the selected variables in our study attributable to the condominium characteristics and the distances to train stations were found to explain nearly 80 percent of the pricing decisions, about 20 percent remain unaccounted for. In order to fully capture the variation in the price offers, researchers may need to include relevant variables associated with the neighborhoods of the condominium projects (Bhor, 2020). Examples of relevant variables could include those such as the crime rate in the area or the number of elementary schools close to the project. Second, although the details of the condominiums were extracted from the sale announcements by our Python script, it is possible that some data were not obtained because of differing display formats of the announcements. The presentation on a screen may look identical even though the details may be arranged differently. Although we did our best to cover all technical possibilities, we must note this possible limitation.

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